Defining, Operationalizing and Classifying Socio-Ecological Risks

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SciencesPo
LABORATOIRE INTERDISCIPLINAIRE
D'ÉVALUATION DES POLITIQUES PUBLIQUES

LIEPP Working Paper
November 2024, nº170

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How to cite this publication:
MANDELLI, Matteo, BEAUSSIER, Anne-Laure, CHEVALIER, Tom, PALIER, Bruno, **Defining, Operationalizing and Classifying Socio-Ecological Risks,** *Sciences Po LIEPP Working Paper* n°170, 2024-11-26.

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Abstract

Both the ecological crisis and the policies set up to combat such crisis – pursuing the so-called green transition – are belonging to a 'third wave' of social risks after the ones connected to industrial and post-industrial transformations. We may label these new risks as 'socio-ecological risks'. Despite a growing number of studies attempting to build a bridge between the notions of social and environmental risks, a conceptual and analytical ambiguity is still prevalent in this emerging literature, preventing us to empirically define, identify and measure socio-ecological risks. Against this background, the paper has a threefold goal: first, it provides a definition of socio-ecological risks as significant changes in the magnitude and/or distribution of social risks, which occur directly because of climate change or other environmental hazards, and/or indirectly due to the distributive effects of environmental policies; second, it puts forward a theoretical model for the operationalization of this concept and the assessment of who is at risk, stressing the importance of four key elements: pre-existing vulnerability, exposure, dependency and eco-social policy mixes; and, third, it proposes a taxonomy to classify these risks, distinguishing between direct and indirect socio-ecological risks, and their social consequences, including income poverty, job losses, housing problems, issues of mobility, food insecurity, declining health and social exclusion. The paper relies on a thorough and critical literature review of established social science debates on social and then environmental risks, connected respectively to welfare state and environmental hazards studies. Aspiring to fill the gaps in the literature, the paper aims to advance a research agenda for the analysis of socio-ecological risks, which should guide future empirical studies in determining what are these risks and who is at risks.

Keywords: socio-ecological risks, social risks, environmental risks, eco-social policies, environmental hazards, welfare state, climate policy, just transition

Social–Ecological Transitions

It is now widely accepted that ecological transitions, in their different dimensions (mitigation, adaptation) and areas (climate-energy, biodiversity and ecosystems, resources), arise from social dynamics and entail social impacts (representations, social relations, trust, cooperation, inequalities, participation, resistance, etc.). This intersection of ecological transitions and social issues is now manifest in numerous academic works and public policy initiatives, but it is still far from producing consensual, useful and operational knowledge for policymakers and citizens. The SET (Social-Ecological Transitions) initiative was precisely launched in February 2024 at Sciences Po with the aim of encouraging collaborations between researchers working at the frontier of social and environmental issues, beyond disciplinary or institutional boundaries to advance this knowledge.

This Working Paper, published in LIEPP's Working Papers collection, is also part of the Socio-Ecological Transitions Initiative's (SET) paper series.

SET PAPERS n°3

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Introduction

Prompted by the worsening of the climate crisis, academics have recently begun to investigate the interconnections between social policies and environmental transitions. This has resulted in the emergence of a new field of study, around 'sustainable welfare', a paradigm that advocates for an ecological reform of the welfare state, guaranteeing human needs within planetary boundaries (Hirvilammi & Koch, 2020). This field of study has grown quickly in the last fifteen years (Cotta, 2024) resulting in different proposals to achieve a sustainable welfare state, mainly through eco-social policies, i.e. public policies aiming to achieve social and ecological goals in an integrated way (Mandelli, 2022). Most of the existing contributions adopt a normative approach focusing on the eco-social policies that the State should implement, including examples such as consumption floors and ceilings or universal basic services and income (Büchs et al., 2011; Gough, 2017). In this relatively new research field, the socio-ecological risks to be tackled by sustainable welfare states and eco-social policies have been central from the start, but often not very well defined and specified. This literature labels such risks differently: 'new social risks of climate change' (Schaffrin, 2014), 'a third generation of social risks' (Johansson et al., 2016), 'social risks of environmental origin' (Gough, 2017), or 'eco-social risks' (Hirvilammi et al., 2023). While broadly interchangeable, here we use the notion of socio-ecological risks, both for matters of simplicity and because this term encompasses both climate change and other ecological issues.

In a symposium published in 2008 in the *Journal of European Social Policy*, a number of prominent scholars came together to highlight the implications of climate change for social policies, using social risks as analytical lens (Gough et al., 2008). Later publications also attempted to reflect on the characteristics of the social risks produced by climate change and (more rarely) by other ecological issues, bringing attention to the potential role of social policies and welfare states in managing the consequences and impacts of climate change on individual lives and wellbeing.

Despite a growing scholarly interest, knowledge of socio-ecological risks is arguably still limited due to the scarcity of studies and key limitations in the existing literature. Against this backdrop, the paper has a threefold goal: to provide a definition qualifying socio-ecological risks; to provide a theoretical model allowing to operationalise this concept and to assess who is at risk; and to propose a taxonomy of these risks. In this sense, this paper aims to propose an empirical research agenda for the study of socio-ecological risks. As such, it should lay the foundations for future empirical studies capturing this new wave of risks. Methodologically, the paper relies on a thorough literature review, building on an interdisciplinary state of the art. In particular, to derive a definition, operationalisation and taxonomy of socio-ecological risks, the paper draw insights from established literatures on social risks and environmental risks, which are reviewed here in an historical perspective. All in all, the paper provides an original contribution that moves beyond the state-of-the-art in at least three major ways.

First, we contest the unpredictability and fuzziness of these socio-ecological risks. Existing analyses underline that a very high uncertainty would make socio-ecological risks radically

different from traditional social risks. Various authors argue that uncertainty here has to do with the diffused spatial-temporal scope and scale (Johansson et al., 2016) of socio-ecological risks, which would be hardly confinable within the boundaries of national welfare states (Gough & Meadowcroft, 2011) and would be more likely to appear in a long-term time horizon: 'for example, rising sea levels are predicted to become highly critical within the next 50 years, but are hardly influential today' (Schaffrin, 2014: 4). According to existing studies, while traditional social risks are individually unpredictable but collectively predictable, climate change would also introduce an element of collective unpredictability (Gough et al., 2008). This is connected to the so-called 'super wicked' nature of climate change itself, a phenomenon whose causes would be too ambiguous and hard to observe 'to be resolved by rational planning and public policy responses' (Johansson et al., 2016: 98). In this respect, Hirvilammi et al. (2023: 4) point out that 'while previous social risks (old and new) were visible because they affected an easily defined section of a population, the social risks associated with climate change are less observable, much more complex and have a much more ambiguous effect on a population'.

This paper fundamentally departs from these assumptions. Despite their undeniable complexity and ambiguity, the ecological crisis and the green transition are already generating tangible risks for different social groups in the present day and, as such, they represent huge challenges for the welfare state, calling for more evidence-based policymaking. Therefore, we aim to go beyond the fuzziness prevalent in the literature by seeking to provide a definition of socio-ecological risks capable of empirically identifying such risks.

Second, the literature on socio-ecological risks does not indicate how to measure who is at risks. A frequent assumption is that the already-vulnerable subsets of the population will also be most at risk. Gough (2017) argues that the subsets of the population that are less responsible for greenhouse gas emissions – and by extension for environmental degradation – would also be more impacted both by environmental hazards and policies. However, this might not necessarily be the case, at least not for all socio-ecological risks. For instance, evidence shows that the lower-middle class often pays the highest costs of decarbonisation (Beaussier et al., 2024). Depending on the circumstances, it might be that, instead of being cumulative and linearly aggravating existing risks, some socio-ecological risks will impact people that would not have been too vulnerable otherwise. Therefore, there is a pressing need to empirically measure the incidence of socio-ecological risks on different social categories and understand who really is at risk. For this reason, we aim to provide an operationalization of socio-ecological risks that can be measurable through existing indicators.

Third, studies frequently assume socio-ecological risks to be new. While the social risks associated with environmental disasters have always existed – since societies have always had to cope with floods, droughts, violent storms, etc. – the ecological crisis is fundamentally altering their incidence, severity, and distribution (Gough & Meadowcroft 2011: 494). Furthermore, socio-ecological risks are often described as a 'third generation of social risks' (Johansson et al., 2016) after those originating from the industrialist and the post-industrial revolutions. It follows that, because these risks originate in the environmental sphere, they

initially appeared to some scholars as 'less connected to changes in labour markets and family structures and thus require a conceptualization beyond the established work-welfare nexus' (Hirvilammi et al., 2023: 4). However, whether socio-ecological risks are new in nature or rather mere amplifiers of existing risks remains to be investigated.

It appears unclear *what* socio-ecological risks are and what makes them so new. Some examples are frequently studied in the literature – such as job losses in decarbonising industries, energy poverty and the spatial inequalities related to environmental disasters – but a systematic taxonomy that goes beyond specific examples is still missing. We aim to build such taxonomy in order not only to shed a light on the specific characteristics of socio-ecological risks, but also to understand what is actually new about these risks and what instead remains constant if compared to first and second-generation social risks.

As we explain below, some of the fuzziness surrounding the notion of socio-ecological risks mirrors ambiguities and polysemy associated with the notion of social risks. To better specify what socio-ecological risks are, section 1 clarifies the notions of social risks and highlights a plurality of meanings and usage. This clarification serves as the basis of section 2, where we consider the social dimensions of environmental risks, and section 3, conceptualizing socio-ecological risks as a third wave of social risks. Finally, sections 4, 5 and 6 are dedicated to proposing respectively a definition, a framework for operationalisation and a taxonomy of socio-ecological risks.

I. Social risks and the welfare state: a multidimensional notion

The notion of 'social risk' is the heart of the welfare state, both historically and scientifically. As Esping-Andersen famously stated, 'an individual risk becomes 'social' for three reasons. Firstly, this happens when the fate of an individual has collective consequences; when the welfare of society is at stake. (…) Second, risks become social because society recognized them as warranting public consideration. And thirdly the growing complexity of society itself means that an ever share of risks originates from sources beyond the control of any individual' (Esping Andersen, 1999: 37). Despite this compelling approach, many different understandings of social risks still coexist in the literature, some emphasizing their consequences (poverty, material deprivation, etc.), some emphasizing their causes (structural changes in societies creating collective insecurities) and some emphasizing the institutions aimed at coping with these risks and the societal demand for risk mitigation. These approaches are not always very precise nor accurate, and oftentimes coexist implicitly in existing works. It is important to clarify and understand the various dimensions of the notion of 'social risk' to assess whether it is relevant when studying how climate change impacts society. Here, we offer an analytical but dynamic set of approaches: each refers to a specific dimension and criterion of what a social risk is, but it also depends on the previous one to make sense, both theoretically and historically. Subsequently, these are not exclusive approaches but rather complementary understandings of social risks.

1.1. Insuring a risk

First of all, what is a risk? As many risk theorists have argued, a risk does not exist *per se*, it differs in this sense from the notions of danger or hazard: risk is first and foremost a social construct (Adams, 1995), a calculation accounting for the probability of some event happening in the future multiplied by its likely consequences (Van Coile, 2016). To be dealt with, it is therefore necessary to be able to calculate the probability of the event to occur and the extent of loss it would induce. In this sense, the notion of risk is closely related to both the rise of probabilistic thinking (Bernstein, 1996) and to the emergence of the techniques of insurance: if an event becomes predictable to some extent, then it becomes possible for people to insure themselves against it. Historically, merchants started to insure their goods and ships as soon as in the 14th century, to protect their investments in long-term journeys and the risk of their boats being sunk by a storm or a war (Bernstein, 1996; Ewald, 1986). Such storms were seen as acts of God (Steinberg, 2006): the only thing that people could do was acknowledge that it could happen and prepare themselves in case it did.

1.2. The rise of social risks: the consequential approach

In the wake of the long-term history of risks, the notion of social risks started to be used in the 19th century in the context of the industrialization of Western societies and the 'Great transformation' (Polanyi, 1944) it produced. As society was changing, new vulnerabilities, new forms of insecurity appeared, but also new ways of dealing with them. A new class of industrial workers emerged. They had to leave their family and communities from the countryside, move to new urban industrialized areas to get a salaried job, losing their traditional sources of family support and welfare when having a child or when growing old for instance. Likewise, new problems appeared such as workplace accidents. All these problems induced an impossibility to work (hence no salary) temporarily (if injured, sick or unemployed) or definitely (if invalid or old). Just as merchants chose to insure themselves against a possible future loss, workers started to insure themselves against such a loss of income due to impossibility to work, and the dramatic consequences of this loss in the new industrial society.

In this *consequential* perspective, a risk is perceived as social because it concerns a person's life and their participation to social activities: it is not so much about losing material goods (like merchants) but getting injured, sick, or old for instance, and risking falling into poverty and deprivation because of the loss of wage income, without traditional support (such as family, community or church) to compensate. Here, a social risk is a risk that concerns the life of a person since it is connected to a loss of income associated with a life event, not a loss of goods. It is 'social' due to its consequences, that are commonly experienced by the members of the same groups. These are risks faced by all people employed in manufacturing industry: they will lose their income if they get injured, become sick or invalid (because of an accident, a disease or old age), or find no job. However, it does not mean that such social risks would necessarily lead to compulsory social insurance: in the beginning, protection mechanisms took

the form of insurance through trade unions and mutual societies. It is only when the causes of these risks were discussed and assigned that compulsory insurances developed.

1.3. The invention of social insurance: the causal approach

For a social risk to lead to the intervention of the State and the implementation of compulsory social insurance, another meaning of 'social' in the understanding of social risks is necessary. It encompasses a shift in the conceptualization of the responsibility for these risks from an individual to a collective responsibility. Here again, the development of population statistics was crucial in acknowledging new and broader societal patterns of insecurity leading workers to face work injury, unemployment, poverty, and sickness. Increases in accidents, health issues, mortality amongst industrial workers indicated that the causes could not be individual behavior but specific social conditions beyond their control.

Workplace accidents have often been the first issue for which collective responsibilities have been acknowledged. As they grow more frequent with industrial development, more and more lawsuits were filed by workers (and their associations) against employers. If, for a while, workers were compensated only as long as their employer's individual fault was proven, at some point, employers agreed to acknowledge their general liability and their collective responsibility, and eventually accepted (sometimes were forced) to participate in the funding of a specific social insurance to protect workers against the consequences of work accident. François Ewald has amply demonstrated how this shift from individual to collective responsibility is at the roots of the emergence of the welfare state (Ewald, 1986).

Historically, some political action was necessary to force employers to recognize their responsibilities in what happens to their employees, and to force the State to support a public response to social risks. As demonstrated by Walter Korpi, it is only after mobilization and strikes by Trade Unions, and the creation of socialist or social-democratic parties (representing industrial workers' interests) that social insurances laws were eventually adopted, either as a reaction to workers pressure (as in the case of Germany in the 1880s) or by governments involving workers parties (as in Nordic countries) (Korpi, 2008).

Risks endured by industrial workers came to be seen as social as it was acknowledged that changes in society caused them, not God, not individuals and not workers recklessness. The recognition of social responsibility enabled the development of 'social' insurance: if society is responsible and every worker can be affected, then everyone involved in the workplace participates in the financing of an insurance (through workers and employers' social contributions) and every worker could be compensated (through the obligation to be covered by such an insurance). Here, a 'social risk' is a risk whose cause is 'social', i.e. society in general is responsible for its happening. It is 'social' by its cause.

1.4. New social risks: the societal approach

In the original understanding of the expression, social risks stem from the socioeconomic changes linked to industrialization, that appeared over the 19th century and are at the heart of the traditional welfare state that expanded in the wake of the Second World War. Since the late 1980s, many studies have assessed the structural changes that also appeared since the 1970s with the transition to a 'post-industrial' economy (Esping-Andersen, 1999). These structural changes (ageing, de-industrialization and the rise of the service economy, entry of women in the labor market, globalization, immigration, dualization of the labor market, etc.) led to what has been called 'new social risks': having a frail relative, difficulties to reconcile work and family life, single parenthood, youth unemployment, having low or obsolete skills (Bonoli, 2005; Bonoli & Natali, 2012; Armingeon & Bonoli, 2006).

These scholars have shown that new problems have emerged because of new social conditions and ways of life, which are not well covered by the traditional welfare state. They have paved the way for a new literature on the 'new welfare state', the 'active' welfare state, and social investment (Morel et al., 2012). However, as interesting as this approach might be, it remains rather evasive and confusing in its use of the concept of 'social risk'. Here, 'social risk' is a synonym of either a (new) 'social problem' or a (new) 'social need': the idea of risk and insurance has faded away and is not necessarily in the equation because some of those risks do not need any insurance, i.e. they are not 'insurable' in the sense that it is not the most relevant policy instrument to be used to cope with these new situations. In fact, most of these new social risks relate to the idea of 'social investment', which is not linked to the technique of social insurance, but more to human capital enhancement through education and active labour market policies (Hemerijck, 2017).

Here, we face a deviation in the approach of 'social risk' in the sense that its purpose is to emphasize a social issue insufficiently covered by the welfare state. New situations appear (such as lengthening of youth, explosion of divorce, new requirement for skills…), creating new living conditions (NEETs, lone parenthood, precariousness…), raising a societal demand for a new policy response identifying new social groups at risk which are not well covered by social insurance-based welfare systems: children, young people, single mothers, unskilled persons, etc. In the societal approach, a risk is social because it needs and requires a socialization through the intervention of the State, whatever the social policy instrument chosen may be. In this sense, it is different from the consequential and causal definition, which were inherently linked to the insurance technique.

1.5. The socialization of social risks through the worlds of welfare regimes: the institutional approach

Despite its importance in the welfare state field, the concept of social risk has also been criticized. Two main critiques have been addressed. First, social risk is often linked to the technique of social insurance. Still, the welfare state is far larger than this specific instrument of social policy: it also includes means-tested benefits and social services for instance.

Sticking to a strict definition of social risk (not being a synonym to social need/problem) does not allow to fully embrace the diversity of situations to be addressed and policy instruments that the welfare state can implement. Second, it has also been argued that the notion of 'risk' overemphasizes the importance of accidents and fatalities, which would not allow for the pursuit of wellbeing in general beyond a simple intervention when something bad happens.

These two critiques underline that the notion of 'social risk' is very linked to the 'Bismarckian' welfare state (Palier, 2010). In fact, in such a welfare regime, social policies try to address the specific aspects and mechanisms of social risks as such, through the use of social insurances. However, other traditions of welfare intervention have focused on other types of social policies, beyond the idea of social risks.

Esping-Andersen has famously shown that the heart of the welfare state is not the idea of social risks, but that of social citizenship and decommodification (Esping-Andersen, 1990). It can take the form of social insurances and contributive social benefits in the 'conservative-corporatist' welfare regime, that puts particular emphasis on the pivotal concept of social risks, but not necessarily: in the 'liberal' regime, the principal concepts remain need and poverty – which relate more to the consequences of social risks – leading to the use of means-tested benefits, while in the 'social democratic' regime, the principal objective is vertical redistribution (not horizontal, like with social insurances) as well as empowering individuals even before a risk can appear, mainly through social services and flat-rate universal benefits. In this perspective, as in the literature on new social risks, when scholars use of the notion of 'social risk', it appears to be a synonym of 'social needs': for instance, in the paper on 'needs and risks in the welfare state' from the *Oxford Handbook of the Welfare State*, it is interesting to see that Zutavern and Kohli (2010) do not actually use the term 'risks', although it is present in the titles, but only the term 'needs'.

As a result, we can derive a final approach to social risks: it is 'institutional' as it does not concern social risks *per se*, but the way the state eventually copes with them. Hence, it is an *ex-post* way of understanding social risks. In fact, in most countries, the list of 'social risks' is rather small and roughly standardized: old age, health, unemployment, work accidents, occupational diseases and in some countries family (having a child increasing financial burden). These officially-acknowledged social risks are institutionally linked to the social protection system. From an institutional or legal perspective, if a risk or problem does not relate to a specific social policy, then it is not a 'social' risk yet. It is therefore here a tautological definition of social risk (a social risk is a risk that has been socialized by the state, beyond mere social insurance), which is partly independent of what the risk is in reality. This is the definition mostly used by legal experts.

1.6. To sum up: varieties of approaches to the definition of social risk

In order to use the concept of 'social risk' in a rigorous way, we need to be clear about the different approaches that have historically been put forward to define such a concept. After this short review, we can see that there are four ways of understanding 'social risks', which we sum up in Table 1:

Table 1: Varieties of approaches to 'social risk'

	Consequential	**Causal**	**Societal**	**Institutional**
Crucial dimension of the risk	Its consequences (social harms or costs)	Its causes and responsibilities	Its problematization (identification of new issues and at-risk groups)	Its recognition and institutionalization by welfare state institutions
Meaning of social	Social as linked to the life of people (as opposed to goods)	Social as society in general originated the risk and is responsible for it	Social as a social demand/need by specific groups at risk for a policy response	Social as socialized through risk institutionalization in the social protection system

Source: Authors elaboration based on the literature

These approaches may fruitfully be considered when thinking about the new risks associated with climate change and the ecological crisis. The first 'consequential' approach emphasizes the consequences of a risk on the concrete lives of people. The second 'causal' perspective points to societal responsibility: social risks started to be dealt with by the state when they are no longer seen as acts of God or individuals, but as produced by society in general. The third 'societal' approach identifies a list of issues and groups that the welfare state should take into account (or 'socialize') and protect. And the last 'institutional' perspective points in the direction of identifying the varieties of policy instruments actually implemented in order to address specific risks or social problems. As already stated, these approaches are complementary to one another, since they have contributed to refine our understanding of social risks throughout the history of the welfare state. For this reason, we argue that these approaches should also analytically inform the construction of a definition of socio-ecological risks.

II. Environmental risks and their social dimension

Considering environmental transformations (climate change, loss of biodiversity, pollution…) as a source of social risks, or, to put it differently, considering environmental issues as social questions, is a recent and radical departure from previous conceptualisations, which historically regarded the losses associated with extreme weather events as mainly material (as opposed to social) matters, relevant for the realm of private insurance rather than the welfare state. Normatively, the legal concepts of 'acts of Gods' in common law countries or '*Force majeure*' in continental Europe (or '*catastrophe naturelle'* in French) carried the view that environmental disasters such as floods, wildfires, droughts, were rooted in exceptional circumstances, both unpredictable and unpreventable. Acts of God were defined as severe, unanticipated natural events for which no human is responsible in United States tort law (Faure et al. 2024) suspending ordinary liability rules. This view has however increasingly come into question for two reasons: one relates to the evolution of our understanding of the linkages between environmental disasters and society, through the recognition that the consequences of environmental hazards are collective and involve distributive issues. Second, there is an increasing recognition that the cause of these events is also social, linked to the manufactured dimension of climate change, thus questioning the relevance of the notion of act of Gods in a world where material and social harms due to extreme weather events are more and more acknowledged to be caused by human activities.

2.1. Beyond the hazard: the growing recognition of the social consequences of environmental risks

Up until the 1970s, environmental risks were dominantly understood as biophysical events with the emphasis being placed on the naturalness of the event, whose amplitude was assessed by measuring the characteristics of the hazard rather than by analysing the features of the societies impacted. This hazard-centred view (Wisner et al., 2024) also influenced the ways environmental risks ought to be dealt with: being reduced to their biophysical components, interventions were targeted on reducing the physical impact of the hazard through technical infrastructures reducing the probability and severity of the event, and through ex-post compensation (Cannon, 1994) or private insurance. Environmental risks were not conceptualised as social in their nature, origins and consequences and, because they were not considered a social problem, they were neither considered socializable through the welfare state.

Such decoupling between the biophysical dimension of the hazard and the notion of social responsibility for the harm incurred, have been increasingly criticised from the 1970s onward, as social science research started to adopt a more nuanced approach, which would increasingly add another - more social - layer to the analysis of the consequences of environmental risks. This social turn of environmental risk and disaster research put forward the notion of vulnerability, defined as 'the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard' (Blaikie et al. 2014: 254), to emphasise the importance of social factors in

understanding the harm and loss incurred after a disaster. Here vulnerability has a dual meaning: it refers to the individual characteristics of a person (age, gender, health status, social status, etc.) but also to the broader notion of collective vulnerability, which encompasses both preparedness for the hazard and social welfare arrangements, formal and informal (Adger, 1996).

Through the notion of social vulnerability, human geographers, sociologists, development economists and political ecologists have directed attention to the social, political and economic factors that turn an environmental hazard into a disaster and, most importantly, highlighted the social dimensions surrounding the harm and losses incurred after an extreme weather event. They have argued that what makes a disaster is not the hazard itself (the rain or the hurricane) but rather the way people are able to respond to these events in different territories and geographical settings and how well they are equipped to face these events. In short, what makes an environmental disaster is not so much the might of God or the brutal forces of Nature, but the vulnerability of those affected (Watts, 2013; Cannon, 1994; Steinberg, 2006; Tierney, 2020).

By bringing attention to the social factors that create vulnerability and to the social consequences of disasters, those academic efforts to de-naturalise disasters have altered the decoupling of environmental and social risks, and opened the question of the broader social responsibility for losses that will disproportionately hurt the most vulnerable and have long lasting social impact (Cannon, 1994). In turn, these works, by highlighting notions of fairness and equity in public or private responses to environmental risks (Elliott, 2021), have significantly contributed to turn attention to the social risks associated with environmental hazards and to the role social protection can play in absorbing the welfare losses incurred (Adger, 1996). Going back to the above-mentioned consequential approach to social risks, vulnerabilities studies have improved our conceptualisation of the social implications of environmental disruptions on the most vulnerable groups of population, but also more broadly on jobs, income, wealth, economic activity and health. Such attention to the social consequences of environmental risks – as opposed to only the material losses – has reached a wider audience than academic debates in risk and welfare state studies. It is more and more integrated in institutional discourses, carried out by international organisations such as the United Nation office for Disaster Risk Reduction, the United Nation Development Program, the European Environment Agency, and the Intergovernmental Panel on Climate Change (IPCC), emphasising that climate change creates risks of different nature, including social and economic, potentially exacerbating existing inequalities and affecting larger groups of population (EEA, 2024).

2.2. Climate change, climate justice, and human responsibility: the social causes of environmental risks

If the social consequences of environmental risks are now better understood and pointing to the consequential perspective of social risks mentioned above, environmental risks are also increasingly being recognised as caused by society and impacting certain groups more than

others, congruent with the causal and societal approaches to social risks. In the context of climate change, new insights coming from social and legal research have criticised the use of the notion of 'acts of God' to qualify environmental disasters. Instead, risk theorists put forward the notion of manufactured risk, understood as a risk created by the very progression of human development' (Giddens, 1999:4). While manufactured risks first mainly referred to technological risks, debates around the notion of Anthropocene (Steffen et al. 2007) and the disruptions of nature created by human activities are increasingly conceptualizing environmental risks as manufactured risks.

Because the causes of current climate disruptions are human-made, environmental risks cannot be considered 'natural' anymore, but due to certain human activities that should be regulated. Growing legal disputes have invoked the notion of climate justice to engage the responsibility of companies and States for failing to protect individuals from harm caused by climate change. The current multiplication of court cases in the global North points to the collective role and responsibility of the State. This trend mirrors the many court cases by workers against their employers in the 19th Century, which ultimately triggered the socialization of workplace accident risks. For instance, a recent ruling from the European Court of Human Rights recognized in April 2024 an individual right to be protected from the negative impacts of climate change[1]. Increased legal recognition of the responsibility of governments for protecting against the impact of climate change has paved the way for a normative acknowledgment of environmental risks as social risks due to their social cause.

Responsibilities for environmental losses and damages have been revisited with renewed attention to environmental and climate justice, and especially with views on who is most impacted by environmental risks. Legal scholars and activists put forward the notion of 'climate justice' (Schlosberg et al., 2014) to emphasise the many pathways of inequality arising from the impact of climate change and climate policies, at both the global and the national levels (Beck, 2008). At the global level, North/South inequalities have been analysed for long (Jamieson, 2001), showing that the impact of climate change is stronger in vulnerable countries – namely in the global South. These inequalities are even less tolerable considering that such regions have contributed considerably less to global warming than the global North (Chancel, 2020; Johansson et al., 2016). Such inequalities are also present within national contexts, as the impact of climate change and environmental events are felt more by people with less adaptive capacity (Hirvilammi et al., 2023). Here the societal approach to social risks is relevant, since more and more approaches try to identify who is more (or less) hit by environmental changes.

New questions are unfolding regarding what States should do to protect their citizens. Which risks should be covered and how? As private insurance against damages is displaying limits and as the frequency and magnitude of environmental hazards is increasing fast, to what extent are societies collectively responsible to provide protection and prevention against environmental risks? The increased recognition of their social dimension in academic debates

[1] See the ruling 'Verein KlimaSeniorinnen Schweiz and other vs. Switzerland' on April 2024. https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22002-14304%22]}

and in institutional forums arguably paved the way for the recent emergence of the 'sustainable welfare' literature, attempting to build a bridge between the notions of social and environmental risks. This literature emphasizes the role that the welfare state *should* play in response to growing risks, advocating for eco-social policies that integrate social and environmental goals. However, empirical examples of eco-social policies are still relatively rare (Cotta, 2024), which signals that the socialization of risks through the institutions of the welfare state is still underdeveloped.

2.3. From environmental risks to the social risks produced by climate policies

The emerging sustainable welfare literature is greatly influenced by studies on environmental and specifically carbon emissions inequalities (Buchs & Schnepf, 2013). These studies highlight a double injustice for which the subsets of the population that are less responsible for climate-altering greenhouse gas (GHG) emissions – and environmental degradation in general – are also the ones that would be more impacted by and less able to cope with environmental disasters (Gough, 2017). This injustice becomes triple if we factor in the regressive impact of climate policies, which tend to place a higher burden on lower-income people and groups (Büchs et al., 2011). Very often, the contributions in this field target climate change mitigation and adaptation policies[2] and question their fairness and acceptability (see for instance Otto & Gugushvili 2020).

While various studies provide detailed analyses on vulnerability to environmental risks, much less is known about the social risks associated with the transition to a green economy. Climate policies are vital, they have important positive effects such as the enhancement of energy security, the reduction of air pollutants and overall health improvements (Johansson et al., 2016). However, they can also create costs, new forms of inequalities and other distributive issues (Schaffrin, 2014). Climate policies are reported to come with social (and political) costs, which are unequally distributed. The most frequently cited examples in the sustainable welfare literature are, first, increases in the prices of energy, transport and other commodities, which come as a consequence of carbon taxes or carbon budgets, affecting disproportionally lower strata of society; and, second, job losses and other employment transformation connected to the low-carbon transition of productive systems affecting certain groups (and territories) more than others (Johansson et al., 2016). The political costs of such policies are increasingly visible in the political backlash against environmental policies (often organised by radical right parties).

Knowledge about the distributive consequences of environmental policies is still very much developing, with most studies focusing on the social impacts of climate mitigation. There is a general assumption in the literature that those most impacted by these policies are the poorest. However, a recent study found that, in certain cases, decarbonisation affects heavily the subsets of the population that are not necessarily the poorest, notably the lower middle class

[2] In essence, adaptation entails adjusting to the existing consequences of climate change, while mitigation aims at preventing or reducing GHG emission and climate change (Source: European Environment Agency).

(Beaussier et al., 2024). Other studies seem to suggest that a key word to understand who bears the risks of decarbonization and other environmental policies is 'dependency'. The argument is that the territories whose economy depends more on carbon-intensive sectors are more prone to suffer from economic risks in the green transition (Rodríguez-Pose & Bartalucci, 2023; Oatley, 2023). As we argue below, dependency is crucial not only to determine economic risks, but also social ones.

III. Socio-ecological risks as a third wave of social risks of environmental origin

So far, we underlined the social dimension of the risks associated with environmental hazards (particularly those associated to climate change) and policies. These risks lay at the intersection between two typically separated policy spheres, the social and the environmental spheres, and they have to do with the negative social implications that the latter sphere produces on the former (Laurent, 2015) [3].

We use the concept of socio-ecological risk in order to underline what is social about environmental risks. We argue that these risks can be conceived as belonging to a third wave of social risks[4], following the ones associated with the industrial era (traditional social risks such as work accident, sickness, old age and unemployment) and then the post-industrial ones (the so-called 'new social risks'). In order to systematize our conceptualization of environmental risks as social risks, we need to analyse the various social dimensions of these socio-ecological risks. We do so by referring to the four various approaches (consequential, causal, societal and institutional) to social risks as analysed in the first section of this paper.

First, taking a consequential perspective, we can ascertain that the nature of socio-ecological risks is social. These risks, like previous ones, are borne by individuals, they affect people's lives and have collective welfare consequences. Like old risks, socio-ecological risks concern the probability of experiencing precarious health, sickness and death, income poverty, job insecurity, material deprivation and social exclusion, which are all crucial elements to determine people's resources and opportunities. What makes socio-ecological risks new is that they are expected to amplify or reallocate existing social risks, similarly to what the second wave of social risks did, layering over industrial-era risks. Socio-ecological risks can not only exacerbate the magnitude of previous risks, but also change their societal distribution, affect groups differently and potentially create new vulnerabilities while leaving other unaltered. In this sense, we depart from the literature by first arguing that it is possible to identify who is at risks (hence, this is not totally uncertain), and second by arguing that one

[3] It is worth mentioning that socio-ecological risks describe only one side of the 'bidirectional' link that connects the social and environmental spheres (Laurent, 2015). The negative implications – and the possible risks – for the environmental sphere originating from the (mal)functioning of the welfare sphere fall outside of the scope of this paper, although it still is a relevant one. Some studies indeed show that the welfare state has a considerable ecological footprint (Oatley, 2023), especially since it is designed to complement consumption and production growth, which in turn can produce detrimental environmental harms.

[4] The 'digital transitions' can also be said to be engendering a third wave of social risks. The connections between the two are beyond the scope of this paper. On the social risks of the digital transitions, see Palier, 2019.

should not *a priori* assume that the currently most vulnerable groups in the population will necessarily also bear all the harshest impacts of the socio-ecological crisis.

Second, taking a causal perspective, we show that socio-ecological risks are social risks because they originate from the (mal)functioning of societies and, as such, they are beyond the control of individuals (Esping-Andersen, 1999; Beck, 2008). This was especially evident with industrial-era and post-industrial social risks, which came from epochal economic and societal revolutions, but it is also true for socio-ecological risks. The current state of degradation of the environment is not randomly connected to the normal functioning of nature, nor to 'acts of God'. Instead, in the era of the Anthropocene, human activities are key drivers behind such degradation, mainly through pollution, the extraction and consumption of natural resources, GHG emission and the disruption of habitats. Beyond these direct risks, the policies put in place to fight climate change and fix environmental degradation in turn also generate socio-ecological risks, which are more secondary or indirect. In this case, the social cause is even more evident, given that the emergence of a risk is connected to the functioning of the State. In sum, socio-ecological risks are social in that they are caused by human activities, which in turn generate environmental hazards and regressive environmental policies. It is worth pointing out that, although the existing literature concentrates mostly on risks generated by climate change and climate policies, our concept of socio-ecological risks strives to be applicable to other environmental causes, such as biodiversity losses, or air, soil and water pollution.

Third, in a societal perspective, the emergence of a new wave of socio-ecological risks might exert a novel functional pressure on the welfare state to recalibrate itself in response to such risks (Mandelli, 2023). This is evident in the fact that the academic and political debates around these risks and around their eco-social policy solutions are increasingly gaining salience, signalling that societies are recognising these risks as 'warranting public consideration' (Esping-Andersen, 1999: 37). There is a growing demand for public responses to the social consequences of socio-ecological risks, that go beyond the existing arrangements, mostly based on private insurances and exceptional compensation mechanisms, and that call for redistributive policies and to the implementation of new eco-social policies. In this sense, these emerging debates are comparable to those witnessed in the aftermath of the Second World War, which became 'a social transformer that had a tremendous effect on the entire society and on social policy arrangements' (Johannsson et al., 2016: 97). What is still to be done, is to accurately identify the various groups particularly hit by environmental transformation and policies and thus most exposed and vulnerable to socio-ecological risks.

Lastly, the institutional approach to socio-ecological risks has to do with their actual socialization. The socialization of social risks typically occurs through the institutions of the welfare state, which at its core can be seen as a system of public policies that identifies people's rights to be protected from certain risks. Amongst the several risks individuals are confronted to over their life courses, only a few have become acknowledged by the welfare state, and they are not all tackled with the same type of policy instruments. The same logic can also apply to eco-social policies. Since eco-social policies are new compared to more

traditional welfare state institutions, and the awareness about socio-ecological risks is only timidly emerging, several socio-ecological risks still remain uncovered. Moreover, given the scarcity of empirical studies on these eco-social policies, we still cannot say much about how policy responses vary across different welfare regimes. The fact that the institutional approach to socio-ecological risks is still relatively underdeveloped should not come as a surprise: as shown above, this was also the last phase in the historical development for other social risks. Thus, we can expect that an institutional understanding of socio-ecological risks will also progressively develop in parallel to progresses in State's responses to such risks.

IV. A proposed definition of socio-ecological risks

Once established that socio-ecological risks point to a new generation of social risks, a next step is to further understand the substance of these risks, define what these risks are and who they will affect. We propose to do this by distinguishing between two main subcategories of socio-ecological risks (Schaffrin, 2014, Johansson et al., 2016; Hirvilammi et al., 2023): the first refers to the social risks associated to climate change, and, more broadly, to environmental hazards exacerbated by the ecological crisis. The second refers to the social risks produced by environmental policies. We refer to the former group as 'direct' socio-ecological risks and the latter as 'indirect' ones. Although the denomination is not entirely consensual in the literature[5]. The distinction between direct and indirect risks is a useful analytical tool to understand the mechanisms at play, together with their relationships with prior generations of social risks. In this sense, we define socio-ecological risks as:

Significant changes in the magnitude and/or distribution of social risks, which occur directly because of climate change or other environmental hazards, and/or indirectly due to the distributive effects of environmental policies.

As we explain below, the ways these two types of risks unfold differ significantly. The core components of the risks are associated to vulnerability and exposure to environmental hazards for direct risks and to vulnerability and carbon-dependency for indirect risks. In the following paragraphs, we propose to further break down and explain these different components. We first recall the role of vulnerability, at play for both types of risks, and then scrutinize the role of exposure for direct risks, and the role of dependency for indirect risks. Finally, we discuss the role played by public policies in mitigating risks.

[5] The distinction between direct and indirect socio-ecological risks can be found in several studies, however the definitions of these two groups vary across different studies. Some authors define direct risk as those connected to environmental hazards and indirect risks as policy-driven risks (as we do here), others instead use the direct-indirect distinction to distinguish respectively the immediate or short-term impacts of climate change from the long-term socio-economic changes connected to global warming (Gough et al., 2008; Gough & Meadowcroft, 2011).

4.1. Socio-ecological risks and the intersection with pre-existing vulnerabilities

A main question that the nascent research on socio-ecological risks is raising has to do with their relationships with the social risks of first and second generation, and whether socio-ecological risks are creating new patterns of insecurity or aggravating existing ones (Hirvilammi et al., 2023). In fact, similar questions have been raised in the literature on environmental risks and disasters, which highlighted *ex-ante* vulnerability as a key aspect to determine one's risk (Tierney, 2020). Defined as the *'capacity to anticipate, cope with, resist, and recover from the impact of a natural disaster'* (Blaikie et al. 2014: 254), vulnerability generically indicates the specific characteristics of a person or a territory that accentuate risk sensitivity (Clark et al., 1998). Vulnerability factors range from physical features to socio-economic status and the institutional context where one lives or operates (Adger, 1999; Wisner et al., 2024). What is crucial here is that vulnerability is multidimensional, and it is expected to act as a filter between risk factors (environmental hazards or policies) and outcomes (the actual harm). While it is very risk-specific and context dependent, the broad categories of mechanisms increasing the likelihood of harm typically are: one's state of poverty, job precarity, material deprivation, sickness and social exclusion, which all together are expected to impact one's sensitivity and capacity to react to environmental hazards and policies.

4.2. Exposure as a key component of direct socio-ecological risks

Under its simplest meaning, this notion emphasises the physical exposure, which is associated to the characteristics and location of a disaster, underling the importance of geographic context and of the territorial dimension. However, one needs to enrich it following the definition of exposure adopted by the IPCC, to encompass '*the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected'* (IPCC, 2014: 5). The IPCC's broad definition of exposure is congruent to our definition of socio-ecological risks: exposure here is not understood only in a physical sense but rather incorporates a social dimension, which opens the possibility to build a bridge with the environmental justice research that stresses socio-economic inequalities in exposure to disasters. One's exposure to environmental hazards often interacts with socio-economic vulnerability, making lower-income and marginalised people more at risk because they tend to settle in riskier areas (Hallegatte, 2016). People can be exposed to socio-ecological risks also due to their socio-economic proximity to an environmental hazard. It might be that, even if one lives relatively far away from where an environmental disaster has occurred, they are still hit by such hazard because the latter has caused losses and damages in infrastructure, service or sectors of the economy that are key to one's livelihood. For this reason, here we define *exposure as the physical and socio-economic proximity to an environmental hazard, which is expected to determine the state of susceptibility to be harmed from socio-ecological risks.*

4.3. Dependency at the core of indirect social risks

With regards to indirect social risks, we assume that the likelihood that one will be impacted by an environmental policy depends on whether they are personally concerned with the activities or assets that this policy targets (through tax, regulation or bans) and how much they have alternatives to change their behaviour in order to lessen the costs of the policy. *Dependency* – especially dependency on a carbonated lifestyle, such as working in a brown sector, being dependent on car for transportation or heating a poorly insulated house – is here the main concept characterising indirect social risks. We derive this concept from recent contributions studying the territorial impacts of climate policies, which have highlighted the importance of 'fossil fuels dependency' (Rodríguez-Pose & Bartalucci, 2023), or of the 'carbon economy' (Oatley, 2023) in driving risks in the green transition.

Here we apply dependency to measure socio-ecological risks at the individual, rather than territorial, level. For instance, we can reasonably assume that carbon taxes on car fuels will strongly impact individuals that own or use a car and instead leave those that use public transportation indifferent. However, almost nobody is in such a clearcut situation. Hence, dependency should not be treated as a dichotomous variable, but rather as a spectrum: individuals are highly dependent on certain assets or activities if these provide them basic needs satisfaction. To measure dependency, it is also crucial to assess whether one has alternatives at their disposal to adequately substitute their ecologically harmful assets or activities. All in all, *we define dependency as the extent to which one's lifestyle depends on ecologically harmful activities or assets, which is predicted to determine the state of susceptibility to harm from socio-ecological risks.*

4.4. Socio-ecological risks and eco-social policy mixes:

A last component to take into account when defining and qualifying eco-social risks relates to the public policies put in place to offset and mitigate these risks. The probability of suffering from socio-ecological risks depends indeed on the existence and strength of *eco-social policy mixes*. Factoring in public policies in our definition is useful to highlight that the welfare state has a key role to play in addressing new risks. First, the State can put forward new eco-social policies, which are explicitly designed to address socio-ecological risks (for example through climate mitigation or adaptation policies that integrate redistributive components). Second, States may also rely on already-existing welfare and environmental policies, which might by themselves provide adequate responses to new risks, even though they were originally meant to address other problems. Therefore, eco-social policy mixes comprise both new eco-social policies and established welfare and environmental policies. All together, we consider *eco-social policy mixes as the set of policies providing rights and developing a range of public actions to identify who should be protected from socio-ecological risks and how*. Eco-social policy mixes are expected to vary significantly across countries – most likely mirroring the overarching features of welfare and growth regimes (Hassel and Palier, 2021) – with different types of instruments, targets and levels of protection. For instance, a notable distinction is the one between protective and reactive eco-social policy mixes, with the former aiming to

prevent risk formation and the latter aiming to address risks once they manifest (Mandelli, 2022).

V. The distribution of socio-ecological risks: a framework for operationalization

Having spelled what are the main components of socio-ecological risks, a next step is to operationalize this definition to understand their incidence and distribution. The nascent literature on sustainable welfare has so far provided no clear indication on how to empirically measure these, insisting instead on their uncertain characteristics, which would preclude any operationalisation, calculation, and prediction. While it is true that these risks are very context specific, complex and display important variation, environmental risks and disasters studies provide useful frameworks, indicators and data on issues connected to – although not perfectly coinciding with – socio-ecological risks, which makes it possible to apply a probabilistic approach to the study of these risks.

In the literature on environmental risks, as mentioned above, the dominant approach up until the 1970s, was a rather simple one, which tended to assimilate risks to their biophysical dimension (Tierney 2020), defining environmental risks under their simplest form as: *Environmental risk = Probability of a hazard X its severity*. In turn, environmental disasters do not manifest randomly, but their probability and severity vary across space, making geographical location a key aspect in the calculation of risks (Oatley, 2023).

More sophisticated and more recent understandings of environmental risks added the notion of social vulnerability, integrating another, more social, layer to this conceptualisation (Wisner et al., 2024). In this view, environmental risks are not only the product of the likelihood of a hazard and of its magnitude, but they are also the product of individual and collective vulnerability: *Environmental risk = Probability of a hazard X its severity X vulnerability* (Wisner et al., 2015). This framework has been adopted by the IPCC, that defines risk as 'results from the interaction of vulnerability, exposure, and hazard' (IPCC, 2014:24). This framework is also driving much of the research on climate change adaptation.

We propose here to adapt and integrate the IPCC framework to capture socio-ecological risks in their diversity and to build a model that can be empirically applied to assess who bears socio-ecological risks. We do so through formal modelling, proposing an equation that can be used to operationalise the notion of socio-ecological risks and highlight its core elements and their relation to one another. We especially emphasise the importance of the four elements that we highlighted above as key components of direct and indirect socio-ecological risks: pre-existing vulnerability (v), exposure (e), dependency (d) and eco-social policy mixes (p). Figure 1 illustrates our proposed theoretical model for the operationalisation of socio-ecological risks.

$$\boldsymbol{R = v * (e + d) * \frac{1}{p}}$$

Figure 1: A model to operationalise socio-ecological risks

We hypothesize that the probability to be affected by a socio-ecological risk (*R*) is given by one's exposure to environmental hazards (*e*) and/or dependency on ecologically harmful activities or assets (*d*). The greater exposure and/or dependency, the greater the probability to suffer from a socio-ecological risk. Pre-existing vulnerability (*v*) – that is one's state of poverty, job precarity, material deprivation, health precariousness or social exclusion – acts as a filter or a multiplier, likely making new risks harsher for already-vulnerable individuals. Finally, eco-social policy mixes (*p*) can mitigate the occurrence or magnitude of socio-ecological risks by preventing or reacting to them. In this sense, the relationship between socio-ecological risks and eco-social policy mixes in our model is of an inverse proportionality, because risks are expected to lower with more and stronger policies.

With reference to our proposed model, a couple of important disclaimers should be kept in mind. First, although we argue that to study socio-ecological risks one should pay attention to the four variables described above, we also suggest looking at their interactive effects. In some cases, with high exposure and dependency, direct and indirect risks might be cumulative, but this might not always be the case. Direct and indirect risks might not necessarily layer over one another as the literature often suggests. For example, if one has a high exposure but low dependency, then we expect this individual to be more threatened by direct rather than indirect risks.

Second, it is important to keep in mind that our formula aspires to provide a general theoretical model to operationalise socio-ecological risks as a whole. Therefore, although it appears as a mathematical equation, it shall not necessarily be used as such for calculation. To apply this formula empirically and to quantitatively identify who is at risk, one should construct composite indicators – hence considering important aspects such as social class, age, ethnicity and gender – whose impact is context-depending. For instance, the indicators that one would need to use to assess the risk of poverty from extreme weather events are going to be vastly different from those needed to measure the risks of food deprivation from decarbonisation.

VI. A taxonomy of direct and indirect socio-ecological risks

This section aims at providing a taxonomy of direct and indirect socio-ecological risks, further breaking down direct and indirect risks depending on which of the following macro-categories of harm they concern: i) income; ii) jobs; iii) housing; iv) mobility; v) food; vii) health; and viii) social exclusion. We draw various insights from the literature reviewed above to construct a taxonomy of risk categories formulating hypotheses on what are their most likely

consequences. The categories of our taxonomy mirror those that are most present in the literature. However, other categories might also be added, since this taxonomy is not intended to be exhaustive. Tables 2 and 3 summarise the taxonomy respectively of direct and indirect socio-ecological risks.

6.1. A taxonomy of direct socio-ecological risks

Direct socio-ecological risks relate to the catastrophic phenomena that environmental degradation is producing. Examples of such risks are numerous in the literature, and they include risks connected to one's resources, social status and heath condition. The consequences of socio-ecological risks can both appear immediately in the aftermath of an extreme weather event but also over a longer period, as we can distinguish rapid-onset from slow-onset disasters (EEA, 2024). In the short run, for affected people, extreme weather events are sources of income and job losses; they cause damages to housing, mobility infrastructures and food chain; they might worsen health conditions or even cause death; and they might jeopardise a proper access to social life. In the long term, extreme weather events may trigger other social risks, causing 'risk cascades' (EEA, 2024) that affects larger domains of society. Long-term direct risks include distress migration (Gough et al., 2008) or territorial impoverishment leading to loss of economic activity, higher unemployment, increased poverty, higher social and territorial inequalities and weakened public finances and welfare systems (Hsiang & Narita, 2012; Hsiang & Jina, 2014; EEA, 2024).

The most important predictors of direct socio-ecological risks are one's geographic location and pre-existing vulnerability. Regarding exposure, it is now well recognised that environmental hazards are not equally distributed and hit marginalized, remote and deprived territories the most. For example, in southern and central Europe, exposure to droughts and heatwaves is particularly strong, impacting agriculture production and other economic domains like tourism. Especially in Southern Europe, new emerging health threats such as vector borne diseases are posing public challenges, as mediterranean temperatures are now prone to the transmission of tropical diseases (EEA, 2024). In northern continental parts of Europe, regional and local economies that are dependent on tourism, agriculture, fisheries, and forestry – such as the Alps and other mountain regions, coastal regions, as well as large regions in northern Europe – are assessed to be very sensitive to climate changes (EEA, 2024).

The literature highlights that the unequal distribution of exposure often mirrors the unequal vulnerability of populations, leading to an unequal distribution of the consequences associated with environmental hazards. Vulnerability to environmental hazards is directly correlated with income and socio-economic status (Eriksen et al., 2020; Hallegate et al., 2016, Leichenko & Silva, 2014), ethnicity (Shepherd & Binita, 2015), gender (Enarson & Chakrabarti, 2009), disability, health status, immigration status, as well as the nature and extent of social networks (Klinenberg, 1999). Also important is one's level of material deprivation. Direct socio-ecological risks are regarded to be harsher for people with precarious housing, including renters, people living in fragile or mobile homes (Pendall et al., 2012, Diaz Mc Connel, 2017) or in informal settlements (Williams et al., 2019); for those at risk of transport poverty

(Rozenberg et al., 2019) due to socio-economic status, territorial remoteness and unavailable transport infrastructure (Briceno-Garmendia, 2015); and for food-deprived people. Vulnerable groups often live in more dangerous locations and have fewer resources to protect themselves against or cope with losses and damages (Hallegate, 2016; Benevolenza & DeRigne, 2019), which is in turn connected to poorly designed policies that only protect segments of the population and that increase risks in the long term (Elliott, 2021; Steinberg, 2006).

Table 2: A taxonomy of direct socio-ecological risks

WHAT IS THE RISK?	**HARMS/CONSEQUENCES OF THE RISK**
Being financially exposed to environmental hazards	**Income:** losses of income or capital, inability to cope with the costs of an environmental hazard
Working for a firm or sector exposed to environmental hazards	**Employment status:** labour market disturbances, including job losses, relocations, economy decay and forced migration
Living in a house exposed to environmental hazards	**Housing:** loss and damage to housing structure, services and assets
Relying on transport means or infrastructures exposed to environmental hazards	**Mobility:** loss and damage to private and public means of transport and infrastructures, making mobility unaffordable or unavailable
Relying on food chains exposed to environmental hazards	**Food security:** unaffordability or unavailability of food products, possibly leading to malnutrition
Being physically or mentally exposed to an environmental hazard	**Health:** accidents, sickness, and fatalities, as well as excessive stress on the healthcare system
Having social networks exposed to an environmental hazard	**Social inclusion:** inability to participate to social activities and lack of interpersonal or community support to cope with the costs of an environmental hazard

Source: Authors elaboration based on the literature

6.2. A taxonomy of indirect socio-ecological risks

Moving to indirect socio-ecological risks, these pertain to the social consequences of all environmental policies, even though, as mentioned above, the literature concentrates mostly on climate mitigation, ignoring climate adaptation or other environmental policies, such as for instance those connected to nature conservation. The examples of indirect socio-ecological risks most emphasised in the literature pertain housing, transport and jobs. With respect to housing and transport, several studies highlight that carbon taxes can be regressive, placing a higher burden on lower income households and potentially increasing the risks of energy and transport poverty or insecurity (Büchs et al., 2011; Zachmann et al., 2018). These refer to situations in which an individual or a household lack adequate access to energy services – typically electricity, cooking fuels, heating and cooling – or transport services – both public and private ones – which can be aggravated by the increase in fossil fuel prices that climate policies tend to generate (González-Eguino, 2015; Bouzarovski, 2014). As for job-related indirect socio-ecological risks, studies point out that the transition from a carbon-intensive to a low-carbon economy represents a considerable risk for the workers of decarbonizing sectors, the so-called 'brown jobs' in emission-intensive sectors like the extractive sector, hard-to-abate industries or agriculture. Decarbonization hence can cause harm in the form of unemployment, job displacement, new skill needs, but also economic decay for entire communities (Green & Gambhir, 2020; Galgóczi, 2022).

More recent contributions have started to challenge the narrow focus on jobs, housing and transport, bringing attention to other indirect socio-ecological risks. For instance, the transition to a zero-emissions economy can be pursued through policies reducing the consumption of certain goods and services, like meat-based food, air travelling, or fast fashion items. As food, leisure time and other products become less available or affordable, new risks emerge for those whose diet are unsustainable, those who live in remote areas, or in general people with high-carbon lifestyles (Middlemiss et al., 2023). Less examples can be found with respect to the health impacts of environmental policies, which is why these are not included in the taxonomy of indirect socio-ecological risks. However, it is important to point out that some studies highlight that public social expenditure, including notably expenditure on public healthcare systems, might face significant financial pressures as governments reallocate more and more resources to environmental protection (Schaffrin, 2014).

Overall, environmental policies can have a significant impact on people's income, especially when they introduce new costs; they can lead to job losses and other employment disturbances; they might make essential services like housing, mobility and energy unaffordable, potentially worsening material deprivation levels; and, finally, they might exacerbate social exclusion. Therefore, the main mechanism connecting indirect socio-ecological risk to harm is an increase in people's financial and material costs.

We expect indirect socio-ecological risks to impact different social categories if compared to direct risks. Indeed, as already stated, the lower-middle class often pays the highest costs of decarbonisation because they are the ones that are more involved in brown sectors, that use

internal combustion engine cars the most and that tend to live in energy-inefficient private dwellings (Beaussier et al., 2024). However, it is important to underline that, by definition, indirect socio-ecological risks are connected to how environmental policies are conceived and implemented. Therefore, while anyone who depends on ecologically harmful activities or assets is potentially at risks, the emergence and the distribution of harms depends on whether and how governments put forward environmental policies targeting such activities and assets.

Table 3: A taxonomy of indirect socio-ecological risks

WHAT IS THE RISK?	HARM/ CONSEQUENCES OF THE RISK
Dependency on ecologically harmful consumption habits	**Income:** losses of income or inability to cope with the costs of environmental policies, which can make consumption less affordable and available
Dependency on ecologically harmful job markets	**Employment status:** employment disturbances – including job losses, skill needs, relocations, economy decay and forced migration – as a consequence of environmental policies
Dependency on ecologically harmful housing	**Housing**: increasing housing costs due to environmental policies (higher rents, high costs of renovation and retrofitting)
Dependency on ecologically harmful transport means or infrastructures	**Mobility:** increasing mobility costs due to environmental policies
Dependency on ecologically harmful food products and chains	**Food insecurity:** increasing food costs due to environmental policies
Dependency on ecologically harmful activities for social life	**Social exclusion**: inability to participate to social activities due to the environmental policies

Source: Authors elaboration based on the literature

Conclusion

After industrial and post-industrial social risks, a third wave of socio-ecological risks is expected to emerge and to challenge the welfare state as a consequence of increasing environmental hazards and regressive environmental policies[6]. However, despite their timely importance, we still know very little about these new risks, since studies in this field are relatively scarce and arguably characterised by a conceptual-analytical fuzziness that prevents us to empirically predict what these new risks are and who is expected to bear them. This paper has aspired to fill some of these gaps, providing a research agenda for future empirical studies.

The paper has argued that a socio-ecological risk can be defined as *significant changes in the magnitude and/or distribution of social risks, which occur directly because of climate change or other environmental hazards, and/or indirectly due to the distributive effects of environmental policies.* To empirically operationalize the concept, we have stressed the importance of four key elements: pre-existing vulnerability, exposure, dependency and eco-social policy mixes. Through an original taxonomy, the paper has also provided a list of direct and indirect socio-ecological risks, and their social consequences, including income poverty, job losses, housing problems, issues of mobility, food insecurity, declining health and social exclusion.

In conclusion, we believe that 'socio-ecological risks' – as a concept and an analytical tool – has both advantages and limitations. As for the former, the risk approach allows us to go beyond uncertainty and to effectively predict the social impacts of the ecological crisis. Another important advantage of relying on the socio-ecological risks concept is that it brings attention to the welfare implications of the ecological challenges and of the green transition, hence making an immediate link with the welfare state and the need for eco-social policies.

Some important knowledge gaps and limitations remain though. First, to move forward with the operationalization of socio-ecological risks, more studies are needed to provide indexes measuring the various variables in the formula hereby proposed. Second, to verify the soundness and comprehensiveness of the proposed taxonomy, concrete examples of socio-ecological risks in different contexts should be studied further. Third, to understand the (eventual) policy responses of welfare states to socio-ecological risks, future studies should aim to assess whether and how such risks are politicized – hence focusing on the conflicts they generate – in different institutional contexts. Fourth and finally, from a critical point of view, a crucial limitation of emphasizing the importance of risks is that this concept forces us to frame the social dimension of the ecological crisis under a negative light. More attention to positive socio-ecological aspects – notably wellbeing improvements – should complement the risk approach.

[6] As already mentioned, further studies should look at the interconnections between these risks and the ones connected to digitalization of the economies, which are also raising new social risks. See Palier 2019.

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